BLE (Bluetooth Low Energy)-based Safety System for School Bus Network

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Abstract: The advent of Internet of Things(IoT) has provided boundless opportunities in solving real world problems in practical as well as robust approaches. We propose a system, using BLE, to build a safety scheme for concerned parents regarding their respective children to ensure safe to-and-fro commute from home to school and back. Using an Android app, the bus unit will be used to detect when a child boards or leaves the bus. These events trigger a notification messages with relevant information communicated to the parent app as and when the tag interacts with the bus unit. The system is a mobile-based and web-based database-driven application that facilitates status reporting of children to authorized personnel.

Index Terms: Bluetooth Low Energy, BLE, Internet of Things, Android, Transportation Safety System, Child Safety, School Bus.

INTRODUCTION

In the proposed system, we defined a custom IOT (Internet of Things) network using BLE (Bluetooth Low Energy) powered by Google's Eddystone™ beacon technology. The proposed paper[1] theorized this implemented system of a safety scheme developed to send apt notifications to current status of their school-going child. Using two Android interfaces, the system collectively makes use of BLE tags to enforce safety. The Android applications that have been developed are Parent-end and Bus-end. The parent-end app interacts with bus-end app along, with bus identification, as soon as a respective child is in the bus and thus triggers a status change. Eventually, the end transaction takes place when a child exits bus for the day and a brand-new work cycle starts next day.

IMPACT AND INNOVATION

System's primary goal is to address issue regarding child safety. School going children are linked with respective parents to get real time notifications on their android device. The Android app should be used by parent to track status of child who is uniquely addressed by a BLE beacon. System is also cost effective considering long term usability. It reduces number of dangers and risks involved when sending children to school via school bus. Monitoring actions per-child basis rather than tracking status of entire bus. Use of Bluetooth Low Energy powered on Android by Google's open source Eddystone format. BLE beacons having replaceable battery lasting up to 1 year. Feature of tracking multiple children, belonging to different schools, in a single interface for parent.

THEORY

Resources used are open-source APIs by Google and Android Studio for programming the beacons. The system possesses Android mobile-based interface, ASP .NET for web services and SQL Server database-driven application, which together facilitate management and provide information about the children to authorized personnel. The android beacon library provides APIs that define behavior of the beacon. The BBC solution integrates component like RadBeacon to help determine and authenticate proximity of a student. The project will leverage Eddystone (a open Google format to interface with beacon) that will help determine/authenticate a student and management of beacon from Android device/web. A custom SDK will be developed keeping in mind, other beacon providers to bring more flexibility and control costs entire solution integrating with two Android applications in scope for this project.

SYSTEM WORKING AND DESIGN

The system consists of two main components i.e. Bus module and the Parent module. Bus module being an Android Application detects the child wearing Eddystone capable BLE tags and updates the status of the child on the Data Server. Parent module being an Android application helps parent to know about the whereabouts of the child. System Working is described in Fig. 1.
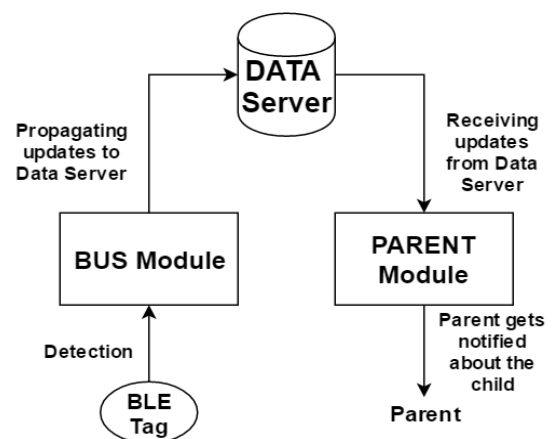

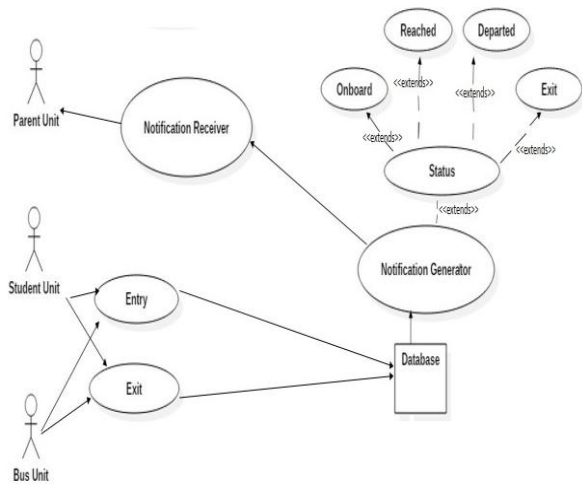Figure 1: Overview

UML DIAGRAM(S)
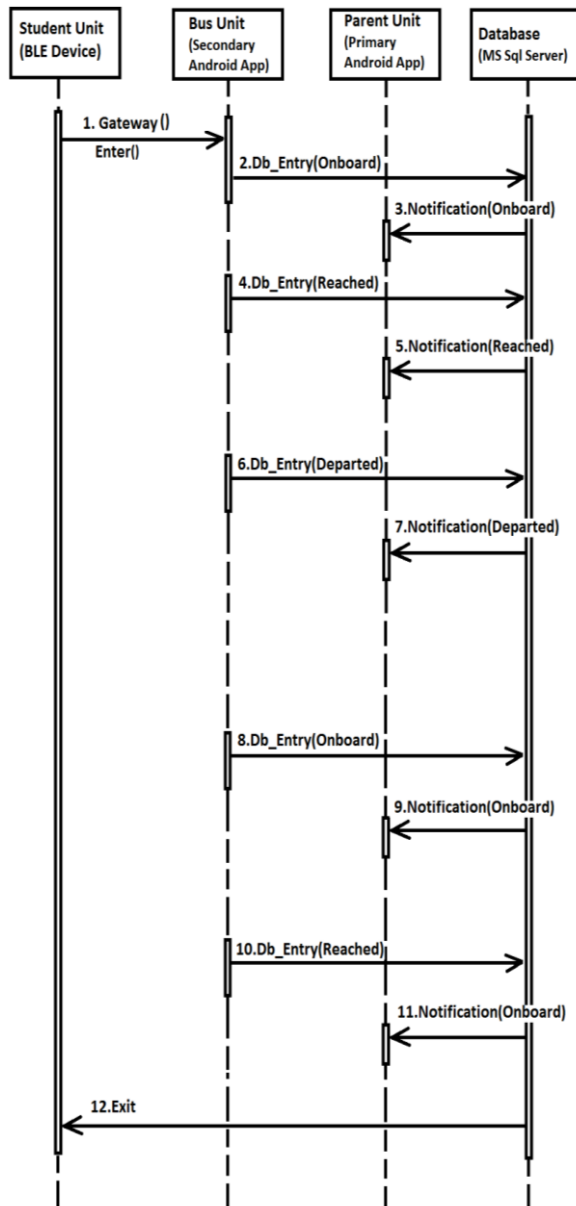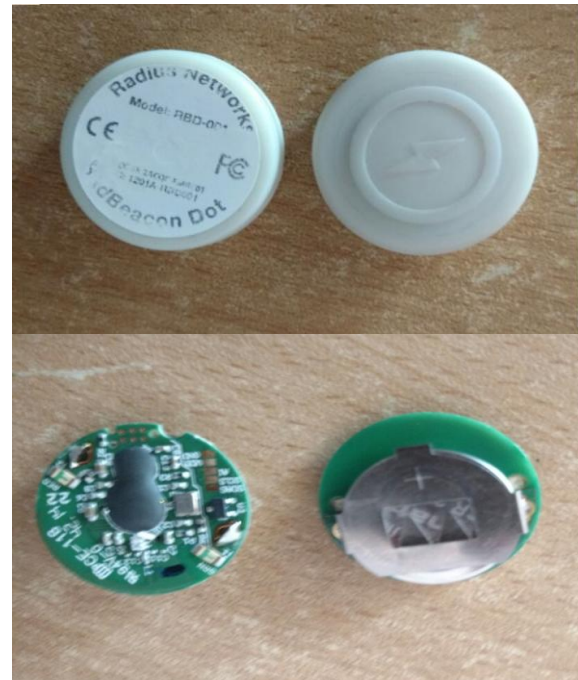

Figure 1: Use Case Diagram

BLE BEACON/DEVICE

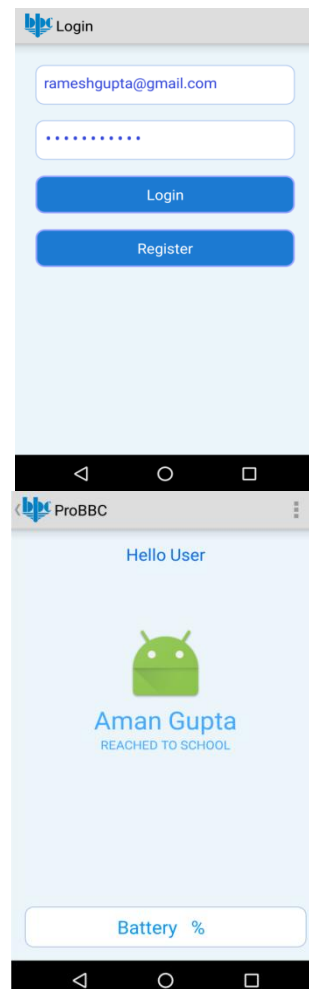## APPLICATION SCREENSHOTS

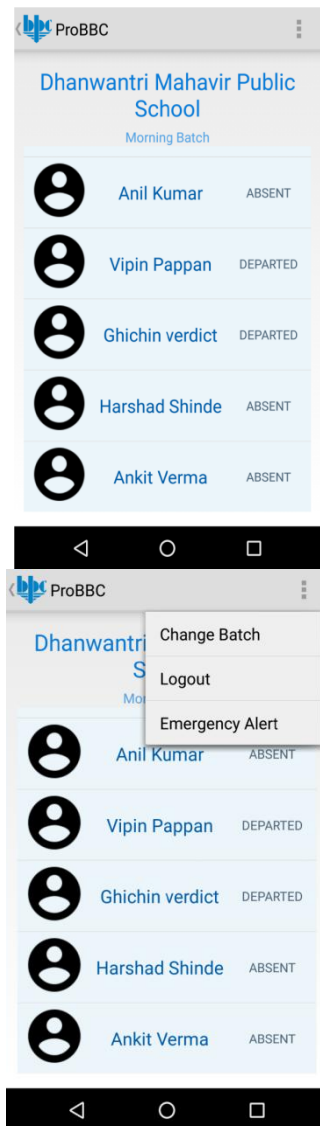Figure 2: Sequence Diagram

Figure 3: Parent app

Figure 4: Bus App

IMPLEMENTATION

I. Components

● Bus Module

Bus Android Application installed on an Android device with BLE Compatibility reads the Eddystone-TLM frame being transmitted by the Eddystone capable BLE tags. Bus Application will automatically detect the tag once the child is in the specified range. The child will be associated with the Bluetooth address of the BLE tag that the child is wearing. Once the child is detected, the Bus Application will send the data to the database server. Bus Application updates the status of the child in the phases as described in Fig. 6.

Fig.6 describes the child detection algorithm which works during the SCAN period. SCAN period refers to the BLE scanning period. When the child is in the vicinity of the Bus/Enters the bus, this algorithm handles the complexity of scanning lot of BLE tags around. Firstly, the MAC address of the BLE tag worn by child is detected, then the updates are propagated over the data server.
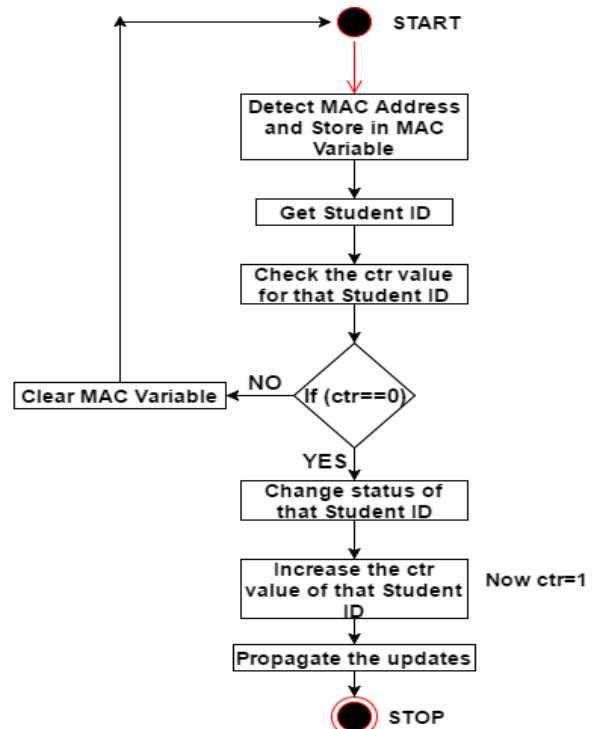

Figure 5:Bus Module : BLE Tags Scanning Flowchart

● Parent Module

The parent unit is an android device equipped with our Application. This app will allow a parent to get real time status of his child. The status of child is pulled from the Database Server upon request. There is a provision for the parent to check battery status of corresponding beacon that is added in the interface. The working of Parent Module is described in Fig. 7.
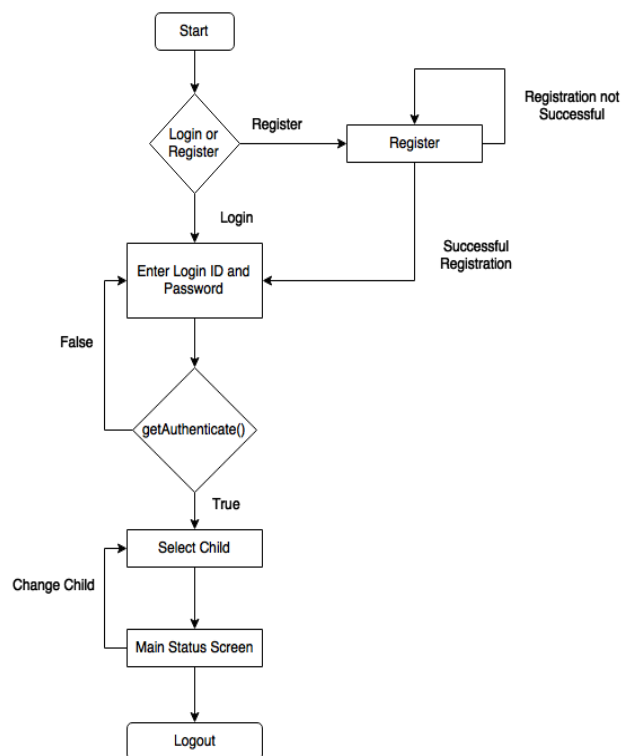

Figure 6: Parent Module Flowchart

II. Database and Web Service

The implemented cloud solution consists of a windows subscription package hosting DotNET Framework 4 running on IIS Web Server and **SQL Server 2012** to store data. The management of beacon will be controlled via. a web interface hosted on goDaddy server on the yearly subscription basis.

goDaddy will be used to host Windows Control Foundation (**WCF**) service built to exchange information between web and mobile(Android) using the JSON protocol(a readable format for structuring data with minimum payload). The web services will help reduce duplication of server code to exchange information.

Front end used to implement Web Servies:
DotNet Framework 4

1. ASP.NET
2. Windows Control Foundation to create Web Services exchanging data in JSON

Use of GCM(Google Cloud Messaging) to send notifications for Android and integrating SMS with fastsms.co.in that will expose API to send SMSs in bulk.

CONCLUSION

Successful implementation of Android application powering BLE beacons enabled using Eddystone format. This system effectively delivers real time status of school going child to parent over Android interface. Application Areas include:

- Primarily for parents to monitor school going child.
- School bus network management.
- School premises tracking.

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